

# *Multi-Sensor Remote Observations of Thin Cirrus Clouds during FIRE Cirrus II*

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# Rationale

*Thin cirrus clouds have important radiative effects (e.g. atmospheric correction)*

- *Difficult to detect*
  - *Low reflectance*
  - *Low temperature contrast compared to ocean*

*Use combination of sensors on NASA ER-2*

- *Multispectral imager*
- *Interferometer*
- *Lidar*

*Study sensitivity and spatial resolution required to detect thin cirrus clouds*



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## *Summary of sensor characteristics*

### *MAS - scanning VIS/NIR/IR spectrometer*

- *11 channels,  $0.68 \leq \lambda \leq 11.95 \mu\text{m}$ , 2.5 mrad FOV*
- *Onboard calibration for  $\lambda > 3.7 \mu\text{m}$ , ground calibration for  $\lambda < 3.7 \mu\text{m}$*

### *HIS - nadir viewing IR interferometer*

- *$\approx 2000$  channels,  $3.7 \leq \lambda \leq 16.7 \mu\text{m}$ , 100 mrad FOV*
- *Onboard calibration, absolute accuracy  $< 1.0 \text{ K}$*

### *CLS - nadir pointing lidar*

- *$0.532, 1.064 \mu\text{m}$ , 1.4 mrad FOV*
- *2 second averages, 15 m vertical resolution*



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# *MAS Specifications (FIRE Cirrus II)*

<i>IFOV</i>	<i>2.5 mrad</i>
<i>Nadir pixel diameter</i>	<i>50 m (at 20 km altitude)</i>
<i>Swath width</i>	<i>86 degrees (37.3 km)</i>
<i>Pixels per scan line</i>	<i>716</i>
<i>Spectral channels</i>	<i>50</i>
<i>Data channels</i>	<i>12 (selected from 50)</i>
<i>Visible</i>	<i>0.68 <math>\mu</math>m</i>
<i>Near-IR</i>	<i>1.62, 1.93, 2.09, 2.14 <math>\mu</math>m</i>
<i>Mid-IR</i>	<i>3.75, 4.54, 4.70 <math>\mu</math>m</i>
<i>IR</i>	<i>8.80, 10.95, 11.95 <math>\mu</math>m</i>



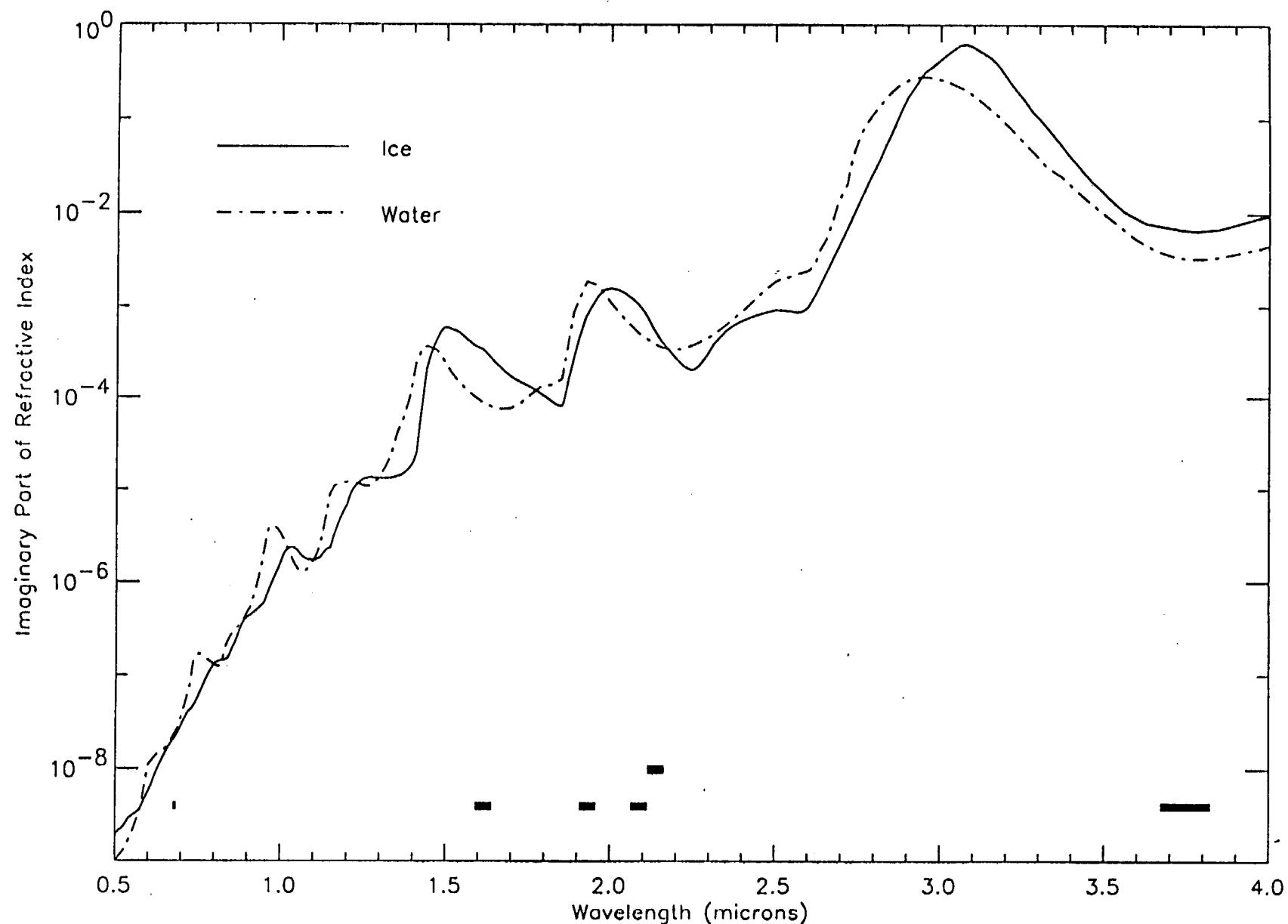
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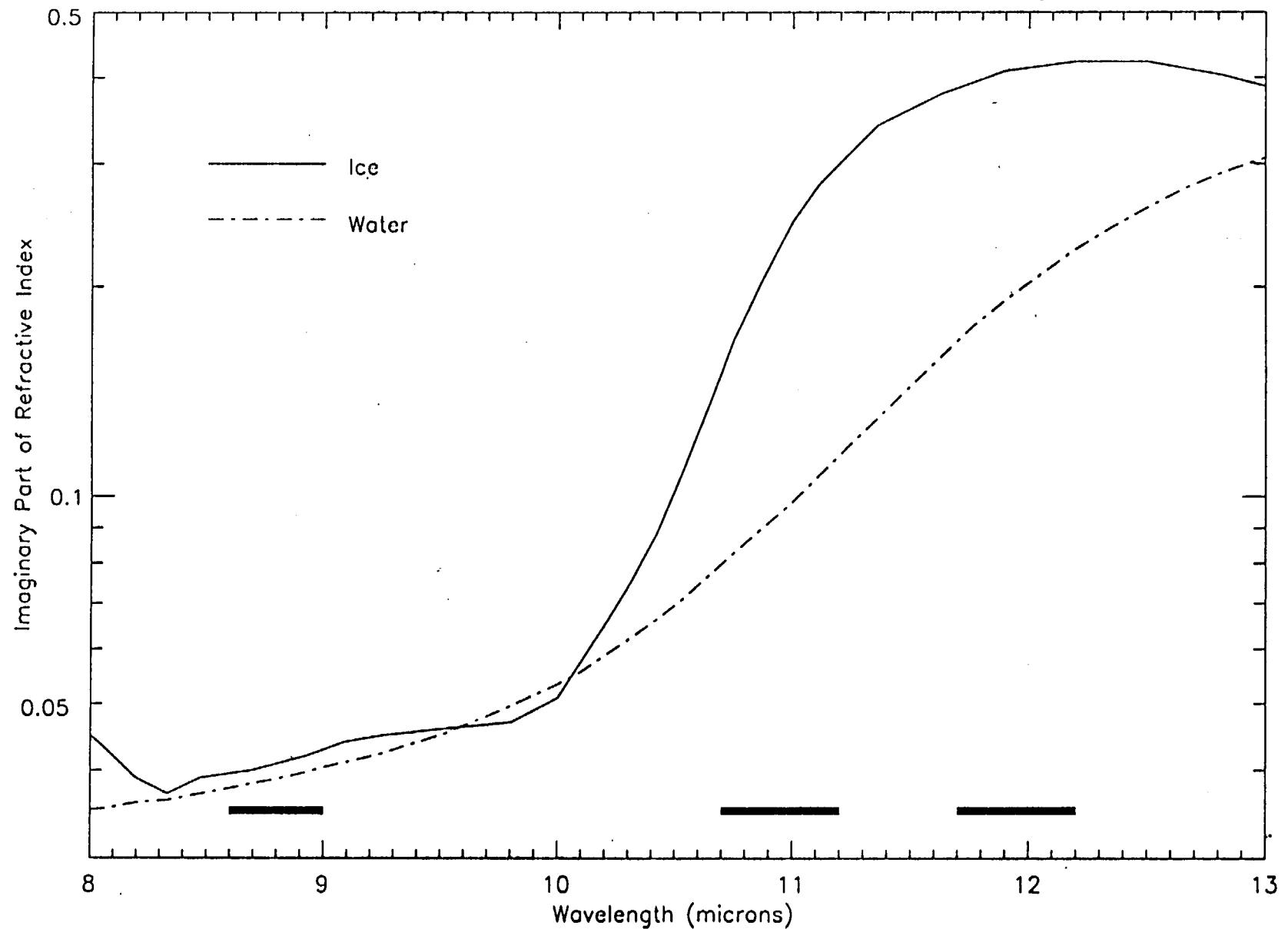
# *ER-2 Flight Line Information 12/5/91*

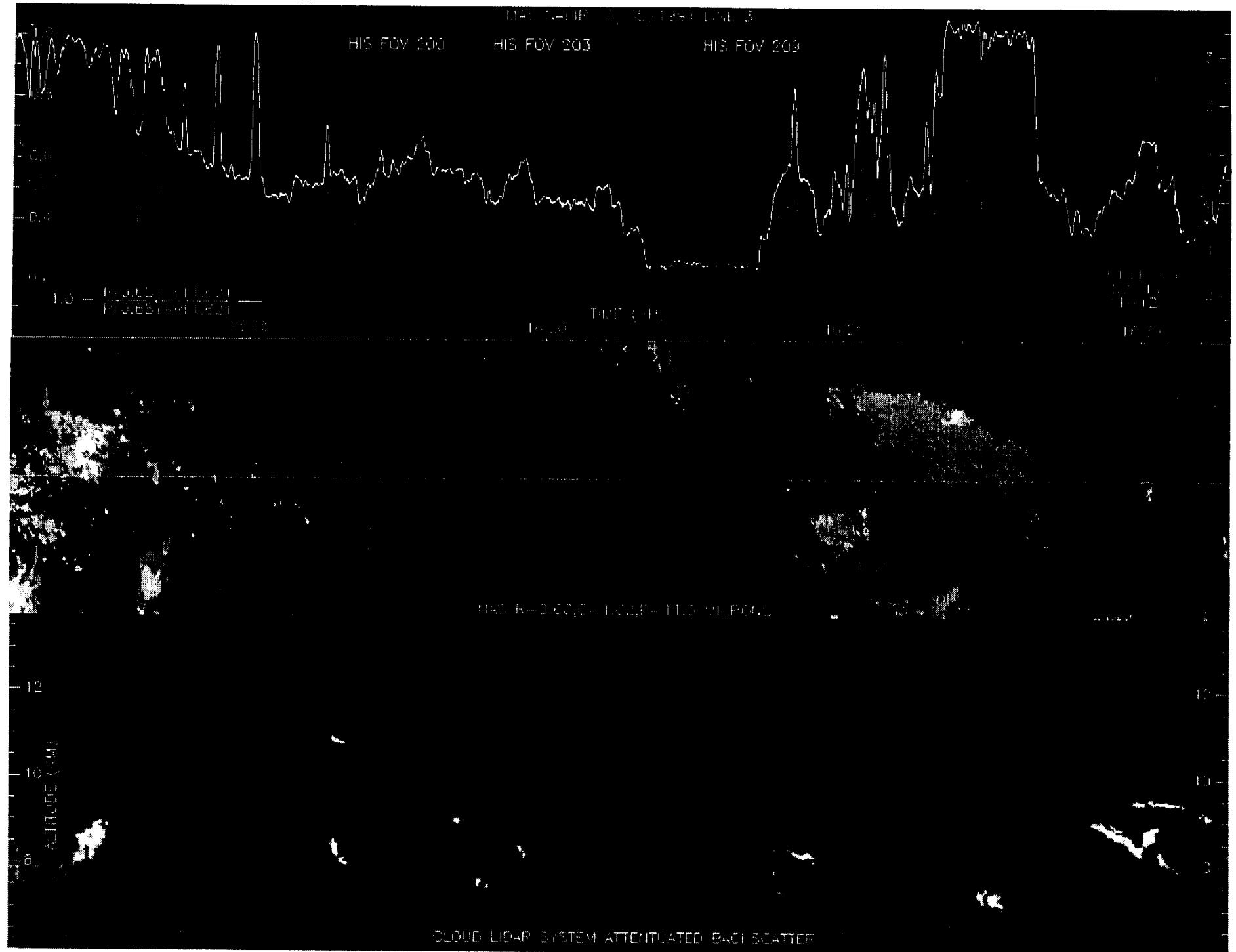
<i>Line</i>	<i>Start</i>	$\theta_0$	$\phi_0$	<i>Heading</i>	<i>Scans</i>
1	15:49:58	59.7	144.6	234.9	3661
2	16:02:51	58.2	146.3	7.7	623
3	16:05:31	58.1	147.0	329.4	5002
4	16:22:42	57.7	150.9	152.2	2414
5	16:33:06	55.8	154.1	337.6	997
6	16:38:17	55.9	155.2	319.3	16057



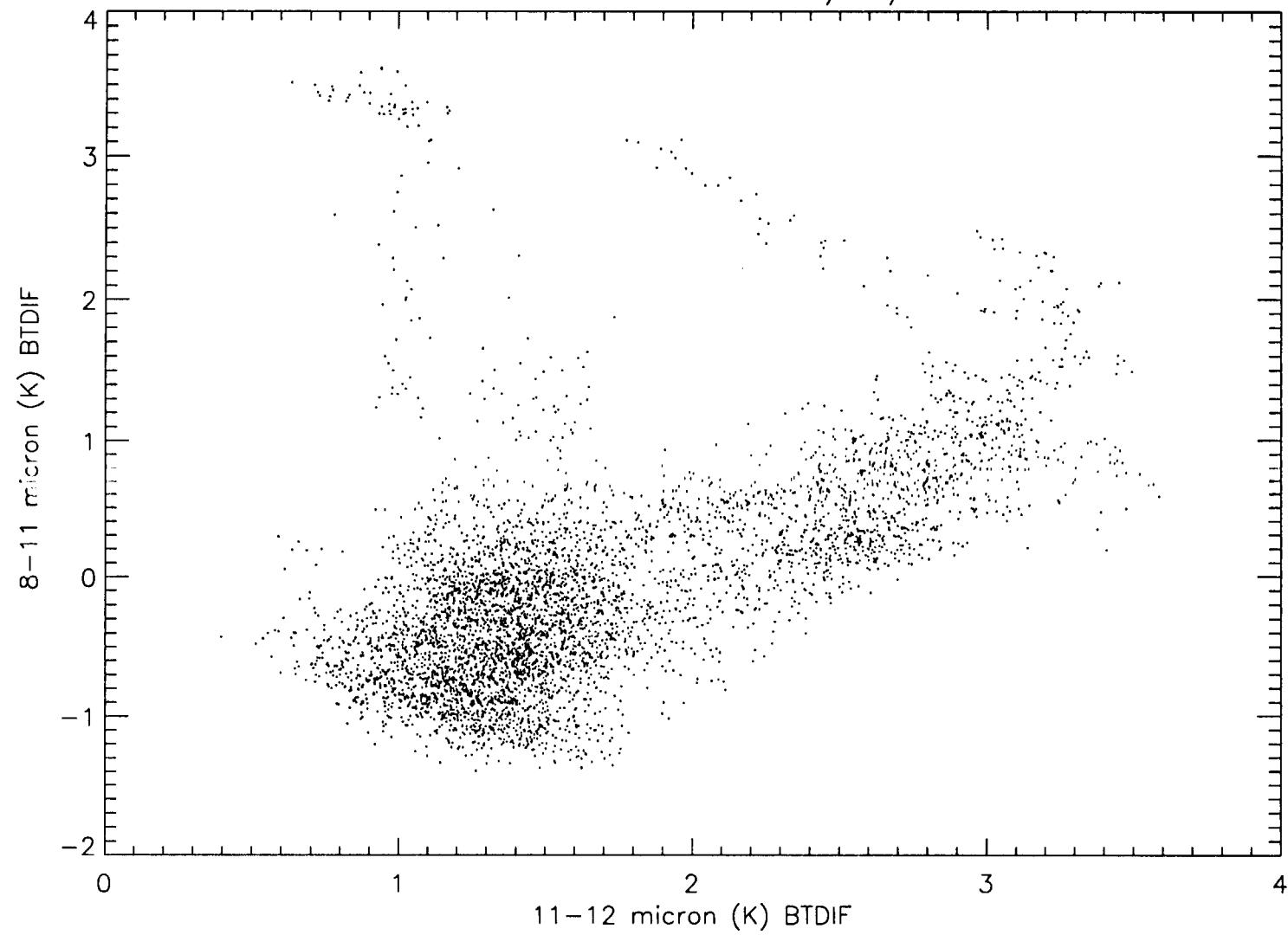
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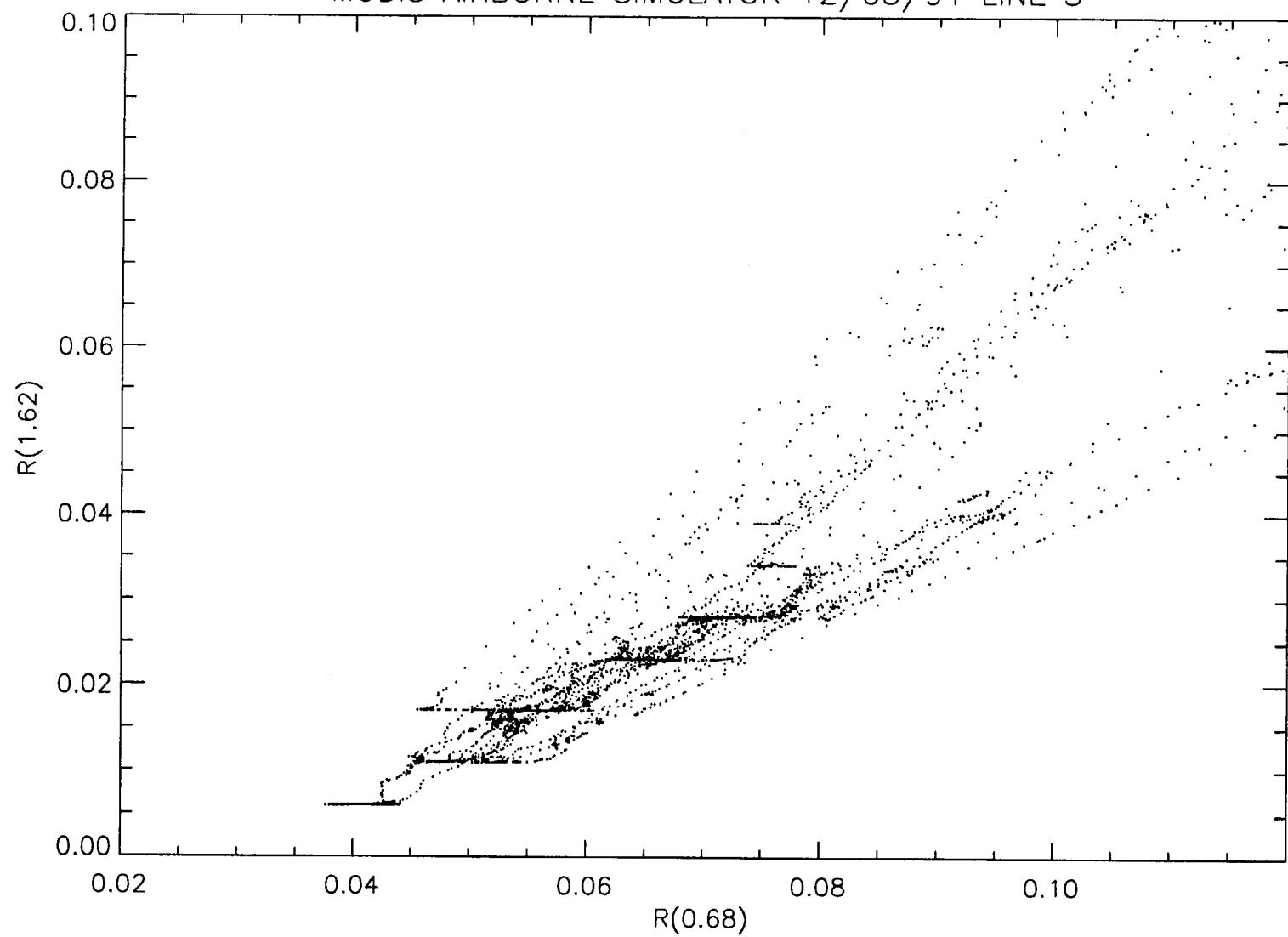


MODIS AIRBORNE SIMULATOR 12/05/91 LINE 3



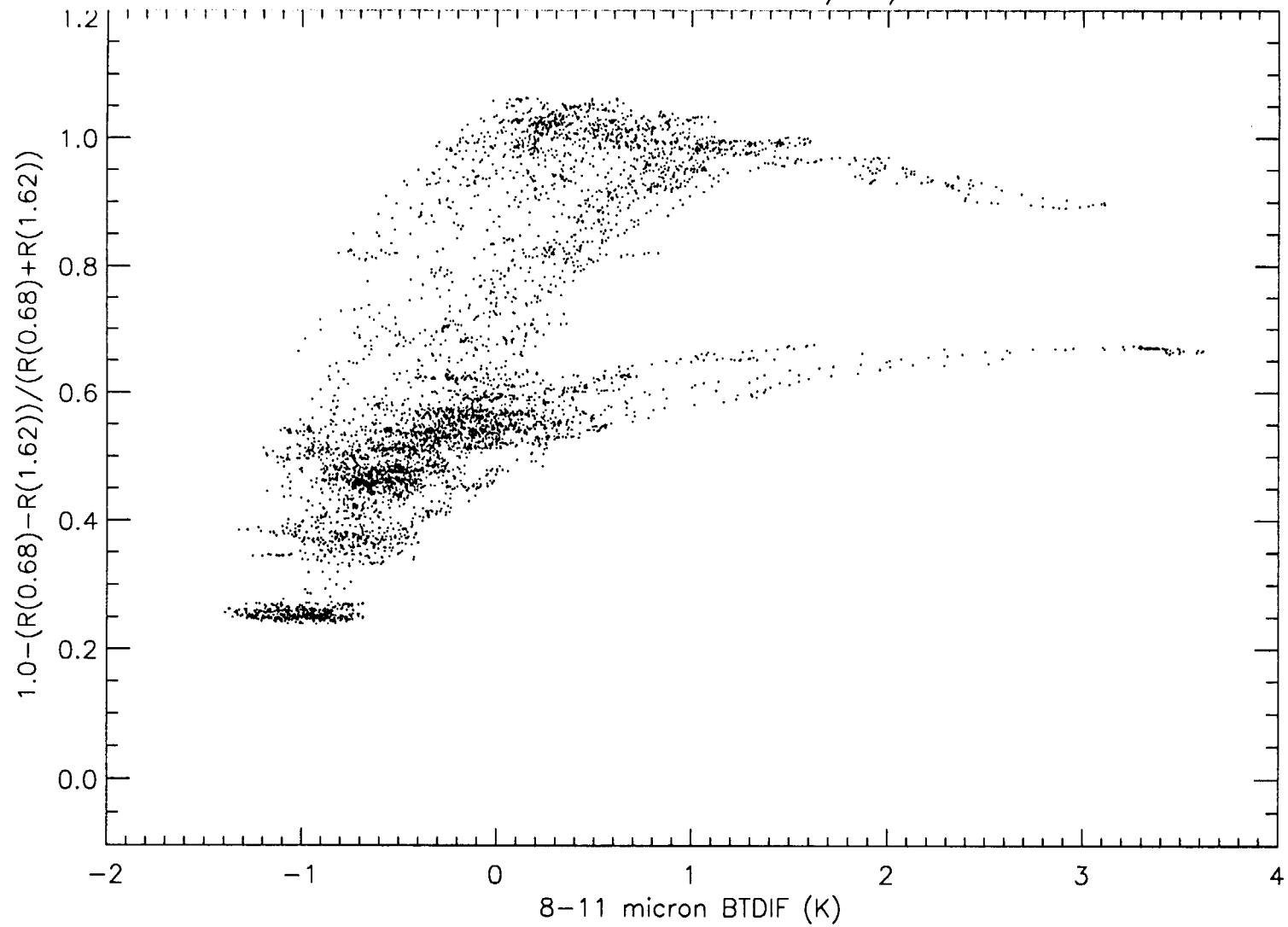
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MODIS AIRBORNE SIMULATOR 12/05/91 LINE 3



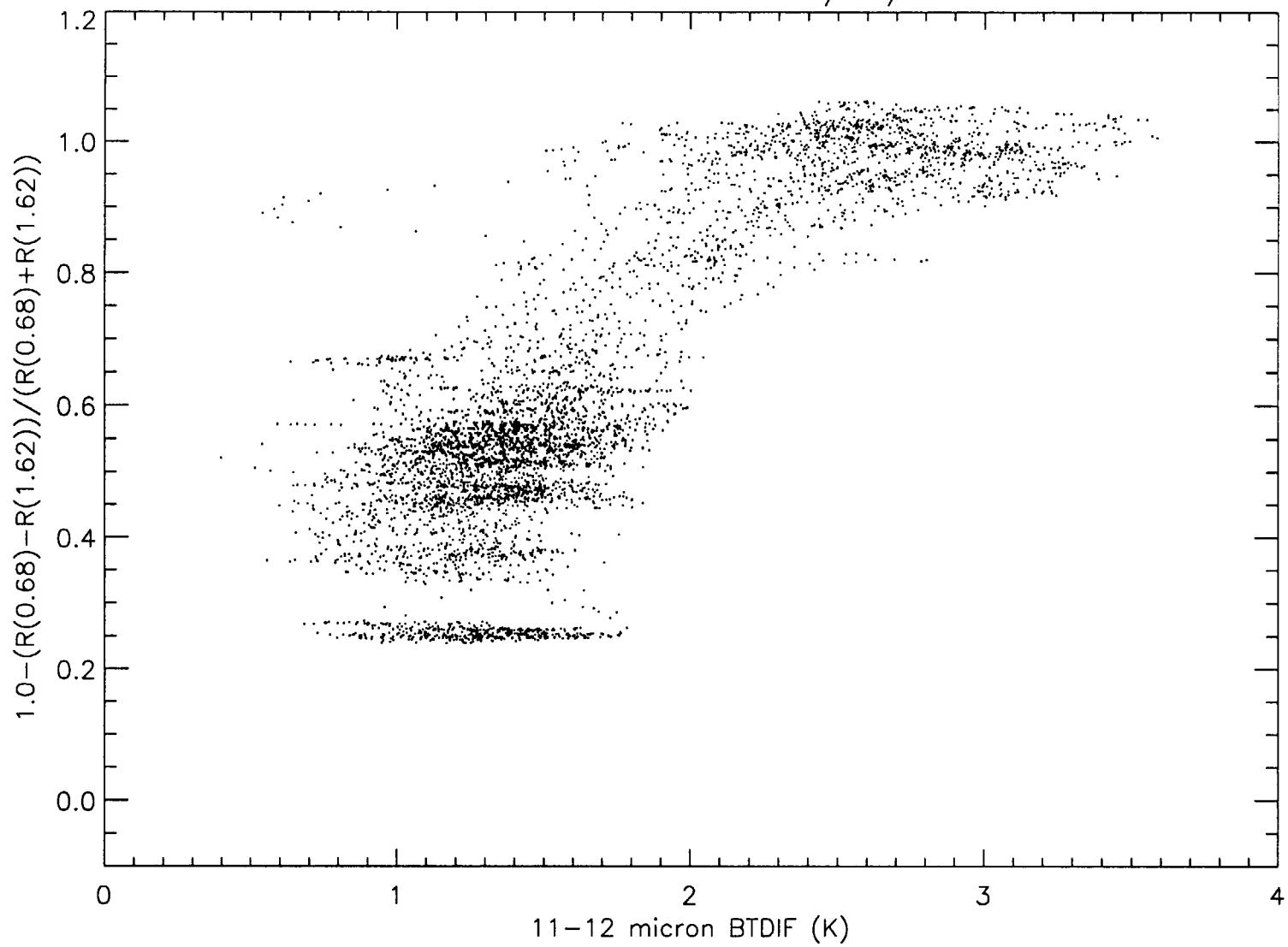
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MODIS AIRBORNE SIMULATOR 12/05/91 LINE 3

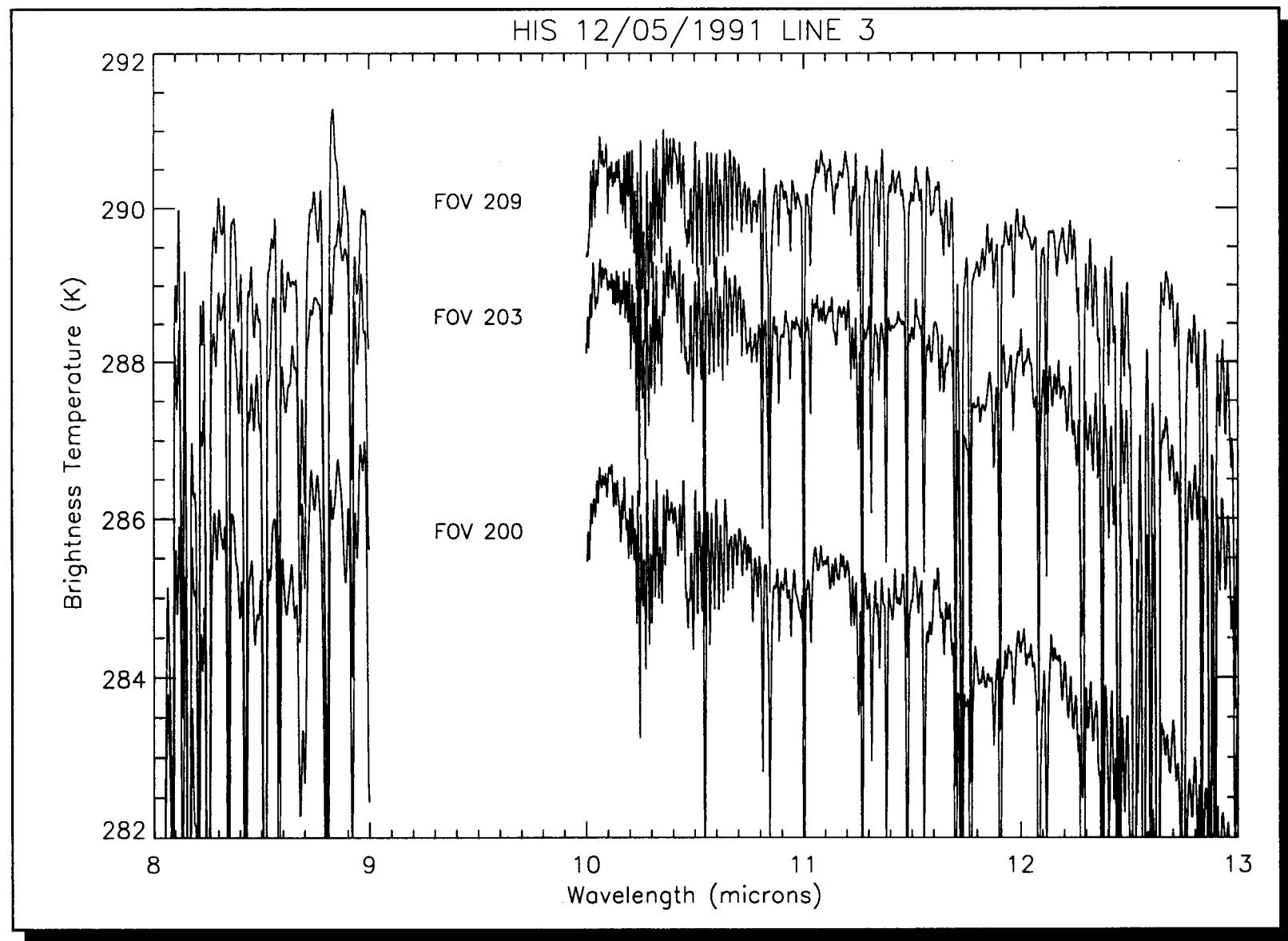


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# *Summary*

*Thin cirrus clouds pose a detection problem:*

- *Single instrument does not tell whole story*
- *Visible, Near-IR, IR information are all useful*

*MODIS cloud mask approach:*

- *Use field observations from multiple sensors*
- *Develop robust detection/classification methods for thin cirrus (threshold, spatial coherence, texture)*
- *Allows possibility of correcting for thin cirrus*



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